Appln. No. 10/650,627
Rule 312 Amendment dated January 26, 2006

Remarks/Arguments

This is an amendment submitted under 37 C.F.R. § 1.312 to improve the grammar and readability of the specification. Most of the changes are self-explanatory, such as to correct tense or to hyphenate compound words, etc.

The following paragraphs show the changes (*i.e.*, by underscoring the additions and by striking through the deletions) that are being made to the correspondingly-numbered original paragraphs of the specification:

[0003] In some situations, it is desirable to transport several fluids at a time along multiple conduits, and, in certain situations, the fluid flow in at least some of the conduits needs to be bi-directional. Designing an FRU to transport several fluids at a time is generally more difficult than designing an FRU that only carries one fluid at a time. In particular, when fluids are not identical, e.g., the fluids are at different pressures and/or temperatures, the design of an FRU is relatively complex. In such designs, the FRU must accommodate fluids at different pressures and/or temperatures while still allowing for relative rotation between incoming and outgoing conduits and ensuring effective sealing with essentially no cross-contamination between the flowing fluids.

[0005] Another FRU, developed by Focal Technologies, is shown in FIG. 1 and is referred to herein as the model 252 FRU. FRU 10 includes an inner first member or shaft 12 and a concentric outer second member 14, which is rotatable relative to the shaft 12. The shaft 12 includes a flange 16 at one end thereof for direct connection to another section of a pipe line or the like. The shaft 12 has a central axially-extending through-bore 18 and an outer cylindrical ~~annular~~ wall 20, which surrounds the bore 18 over its length and is welded to or integrally formed with the flange 16. A

plurality of longitudinally-extending internal bores 22 extend along and within the ~~annular~~ wall 20. The bores 22 each have a different length and terminate at a different short radially-directed bore 24 that communicates the bore 22 with a cylindrical outer surface 26 of the shaft 12.

[0007] Extending between the housings 28 and 30 is a cylindrical sleeve member 36, which is securely fixed, as by annular flanges 38 and 40 and machine screws 42 and 44, to the housings 28 and 30, respectively. Positioned within and filling the annular cavity between the sleeve member 36 and the shaft 12 are a plurality of identical longitudinally-adjacent annular segments 46. With reference to FIG. 1A, each segment 46 has radially-extending face surfaces 48 and 50, a cylindrical outer surface 52 and a cylindrical inner surface 54. Each of the segments 46 includes a circumferentially-extending central groove 56 within the inner surface 54 and a smaller cylindrical groove 58 on each side of the groove 56. A single radial bore 60 extends inwardly from the outer surface 52 of the segment 46 and communicates with the groove 56. With reference to FIG. 1D, each of the segments 46 also includes one or more radially-directed drain bores 82, each of which extends from the inner surface 54 to a drain port 84 at the outer surface 52. As shown, the segments 46 include an annular groove 66 in the face surface 48 and an annular groove 68 in the other face surface 50. The grooves 66 and 68 are spaced at identical radial distances from the axis of the segment and receive a seal.

[0009] The sleeve member 36 has a plurality of ~~circumferentially~~ circularly-spaced apertures therethrough at longitudinal positions corresponding generally to the central radial plane of each of the segments 46. (See FIG. 1A). At each such plane, one of the apertures 74 is in fluid communication with the radial bore 60 of the adjacent annular segment located within the sleeve

member 36. With reference to FIG. 1C, other apertures 78 contain fasteners 80, which serve to properly locate each of the annular segments 46 in its desired position within the sleeve member 36. The fasteners 80 may include, for example, a hollow plug member 88, which extends from a blind bore 90 in the segment 46 through the aperture 78, and a machine or set screw 92 that passes through the plug 88 and is received in a threaded fashion in blind bore 62.

[0012] One embodiment of the present invention is directed to a fluid rotary union (FRU) that includes a concentric first member and a second member. The concentric first member includes a plurality of circularly-spaced longitudinally-directed bores of different lengths extending from at least one end of the first member. Each of the longitudinally-directed bores terminates at an associated radially-directed bore communicating the longitudinally-directed bores with an outer surface of the first member. The second member includes a first housing, a second housing, a plurality of longitudinally-adjacent segments and a plurality of couplers. The first housing is located at a first end of the second member and is rotatably interconnected with the first member. The second housing is approximate a second end of the second member and is also rotatably interconnected with the first member. The plurality of longitudinally-adjacent segments are positioned between the first housing and the second housing. Each of the segments has an outer surface, an annular inner surface and at least one circumferential groove formed into the inner surface for providing fluid communication with one of the associated radially-directed bores of the first member. Each of the segments includes a radially-directed bore extending from each of the grooves to the outer surface of the segment. One of the plurality of couplers is positioned between adjacent ones of the segments, between the segment adjacent the first housing and the first housing and between the segment adjacent the second housing and the second housing. The first member

is positioned within the second member and is rotatable relative thereto.

[0025] The present invention generally overcomes many of the problems associated with the prior art by providing a fluid rotary union (FRU) for use in a fluid delivery system that is capable of transporting multiple fluids with little or no loss of pressure or sealing problems in an economical manner. The FRU can be modified to accommodate different numbers of flow channels and is designed to ensure efficient rotation between incoming and outgoing conduit arrangements. The FRU uses a semi-independent floating design that includes a plurality of individual segments, each of which is effectively coupled to an adjacent segment or segments and/or a housing (i.e., when the segment is an end segment) using a coupler, i.e., a torque transmitting/misalignment device. Each segment contains one or more fluid channels and is capable of "floating" with a central shaft that includes a plurality of longitudinally-extending bores, each of which is capable of carrying fluid. The bores terminate at different locations along the shaft, each such terminal location corresponding to an associated fluid passage within a segment. The fluid can be transported bi-directionally, i.e., in a forward or a reverse direction, along a bore and its associated segment. As described herein, the housing, couplers and the segments constitute one element of the FRU while the shaft constitutes the other element of the FRU, those elements being rotatable relative to each other.

[0027] FIG. 2 illustrates an exemplary partially-exploded perspective view of a fluid rotary joint (FRU) 200, according to one embodiment of the present invention. The FRU 200 includes an inner first member (or shaft) 202 and a concentric outer second member 220, which are rotatable relative to each other. It should be appreciated that an outer surface of the second member 220 may be other than circular. The shaft 202 includes a flange 204 at one end thereof for direct connection to another

section of a pipeline or the like. The shaft 202 has an annular wall 208, which surrounds a central axially extending through bore 206 (when implemented) over its length, and is welded to or integrally formed with the flange 204. A plurality of longitudinally-extending internal bores 210 extend along and within the annular wall 208. The bores 210, which may be equally ~~circumferentially~~ circularly-spaced relative to each other, each have a different length. The bores 210 may extend from the end provided with the flange 204 or the bores 210 may extend from an end opposite the end with the flange 204. Alternatively, the bores 210 may extend from both ends of the shaft 202 (providing the bores 210 do not run into each other). For example, a set of bores extending from the flange 204 end of the shaft 202 may be angularly offset from a set of bores extending from the end of the shaft 202 opposite the flange 204 end. With reference to FIG. 3, each of the bores 210 terminates at an associated short radially-directed bore 230 that communicates the bores 210 with the outer surface of the shaft 202.

[0028] The second member 220 is concentric to the shaft 202 and surrounds the shaft 202 over most of the length of the shaft 202. A first housing 270 at one end of the second member 220 is provided for securing the FRU 200 to another structure of the fluid delivery system, which is not further described herein. The housing 270 includes bearings 272 that engage the shaft 202 and permit the relative rotation between the shaft 202 and the second member 220 while restraining the shaft 202 and the second member 220 relative to each other in an axial direction. As is best shown in FIG. 3, an end plate 240 is attached to the shaft 202 with fasteners 242. The end plate 240 restricts axial movement of a plurality of longitudinally-adjacent annular segments 260. Alternatively, as is shown in FIG. 7, a second housing 270A may be implemented in place of the end plate 240.

[0029] Extending between the housing 270 and the end plate 240 are the segments 260 and couplers 250. As is best shown in FIG. 2, each of the segments 260 has radially-extending face surfaces 262 and 264, a cylindrical outer surface 266 and a cylindrical inner surface 268. With reference to FIG. 4, one or more circumferentially-extending grooves 269 are formed in the inner surface 268 of each segment 260 and a smaller cylindrical groove 267 is formed on both sides of each of the grooves 269. Radial bores 265 extend inwardly from the outer surface 266 of the segments 260 and communicate with an associated one of the grooves 269. Each of the radially-extending faces 262 and 264 include slots 261 for engagement with lugs 252 of one of the couplers 250. As is best shown in FIG. 6, the coupler 250 includes lugs 252 integrally formed on opposite sides of the coupler 250 for engaging the slots 261 in the segments 260. As is shown in FIG. 6, the lugs 252 on opposite sides of the coupler 250 may be orthogonally positioned. The couplers 250 support the segments 260 axially, transmit torque between components of the FRU 200 and allow for some misalignment between the components. With reference to FIG. 5, each of the segments 260 may also include one or more radially-directed drain bores 263, each of which extends from the inner surface 268 to the outer surface 266. Optionally, the segments 260 may be provided with secondary cylindrical grooves in the inner surface 268 spaced axially outwardly from the grooves 269.

The following paragraph shows the changes that are being made to the Abstract:

A fluid rotary union (FRU) includes a first member and a second member. The first member includes a plurality of circularly-spaced longitudinally-directed bores of different lengths, each of which terminate at an associated radially-directed bore communicating the longitudinally-directed bores with an outer surface of the first member. The second member includes a first housing, a

plurality of longitudinally-adjacent segments and a plurality of couplers positioned between adjacent ones of the segments and the first housing and an adjacent one of the segments. Each of the segments has at least one circumferential groove formed into an inner surface for providing fluid communication with one of the associated radially directed bores of the first member. A radially-directed bore extends from each of the grooves in the segment to the outer surface of the segment.

Thus, the foregoing changes simply improve the grammar and readability of the specification. Suffice it to say that none of these changes adds "new matter", the introduction of which is prohibited by 35 U.S.C. § 132.

Accordingly, Applicants' attorney respectfully requests that this amendment be entered so as to clean up the specification prior to issuance.

Respectfully submitted,

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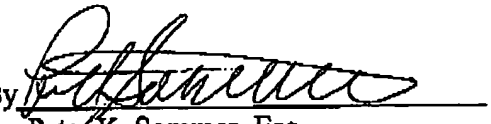
By 

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